VI. Aquatic Ecology

Lakes and ponds naturally contain phytoplankton (algae) and aquatic vascular plants. The amount of phytoplankton and plant growth is related to lake productivity, or the amount of nutrients in the waterbody. An increase in phosphorus results in an increase in alga growth and a decrease in transparency.

A. Plankton

1. Phytoplankton

Phytoplankton are microscopic algae that live in the photic zone of a lake's water column. Whole water phytoplankton include all sizes; net phytoplankton are those that remain in an 80u mesh sampling net. Net phytoplankton data can be found in Appendix VI-1.

The whole water phytoplankton community was commonly dominated by Chlorophyceae, tiny green flagellates (Table VI-1). These are typical of New Hampshire's oligotrophic or mesotrophic lakes. Bluegreens (Cyanobacteria) were dominant on September 11, 1987, and on three sampling dates in late summer/early fall 1988. For all four of these dates the dominant bluegreen was _Merismopedia_. This is in accord with Taylor et al (1979) who found that _Merismopedia_ is more common in the late summer early fall season than at other times of the year. Taylor also found that _Merismopedia_ is commonly dominant in warm, turid and highly productive lakes. While some other nuisance bluegreens such as _Anabaena_ or _Aphanizomenon_ are primarily associated with eutrophic conditions, _Merismopedia_ is often found in New Hampshire lakes and ponds with good water quality, and is not necessarily an indicator of eutrophication.

Excess algae growth generally is not a problem at Mendums Pond. During the study period, however, there were a few isolated bluegreen algae blooms. Bluegreen algae have the ability to regulate their buoyancy. Once they are floating near the surface the algae often concentrate due to wind action and forms a scum on the surface. This scum may be blown into coves and onto exposed rocks, making the shoreline appear to be covered with bluegreen

Table VI-1

Mendums Pond Whole Water Phytoplankton

Community Dominance by Class

Date	Total Density counts per mL	Dominant Phytoplankton Class	% of Total
07/10/87	1088.6	Chlorophyceae (Greens)	52
09/11/87	1503.4	Cyanobacteria (Bluegreens)	63
11/3/87	445.0	Chlorophyceae (Greens)	77
04/19/88	1339.2	Chlorophyceae (Greens)	92
05/04/88	855.4	Chlorophyceae (Greens)	95
06/01/88	263.5	Bacillariophyceae (Diatoms)	48
06/15/88	283.0	Chlorophyceae (Greens)	55
07/06/88	669.6	Chlorophyceae (Greens)	56
08/04/88	1300.3	Cyanobacteria (Bluegreens)	57
09/22/88	864.0	Cyanobacteria (Bluegreens)	58
10/03/88	578.9	Cyanobacteria (Bluegreens)	47
11/09/89	1373.8	Chlorophyceae (Greens)	90
05/16/90	1525.0	Bacillariophyceae (Diatoms)	56

paint. Diatoms (Bacillariophyceae) were dominant on two of the sampling dates; June 1, 1988 and May 16, 1990. This is a common occurrance for late spring and early summer. Diatoms generally do not become a nuisance to lake users, and are common in New Hampshire's lakes.

2. Zooplankton

Zooplankton are microscopic or macroscopic animals that live in a lake's water column. Table VI-2 presents the dominant zooplankton genera in Mendums Pond. The Rotifers Kellicottia, Keratella, Polyarthra, Conochilius and Gastropus were dominant nearly every month sampled. The crustaceans Diaptomus or Nauplius larva were dominant on seven of the 27 sampling dates. There were five sampling dates when the numbers of zooplankton were minimal and no genus was dominant. Low zooplankton density corresponded to low productivity periods such as in the winter season (four of these dates occurred in January or February). The mean rotifer density (37 per L) was greater than the mean crustacean density (21 per L) for the study period. Both of these means are less than the state average for lakes and ponds (the mean rotifer count is 110 cells/L, mean microcrustation count is 54 cells/L). The types and numbers of zooplankton encountered in Mendums Pond are typical of good quality New Hampshire lakes.

B. Periphyton

Periphyton (microorganisms growing on submerged surfaces) are useful in assessing the effects of pollutants on rivers, lakes and ponds. Unlike plankton which are free floating, periphyton more easily show dramatic responses immediately below pollution sources due to their limited mobility. This can provide valuable information of lake quality trends if sampling is repeated over time.

Seven sample stations were selected around the periphery of Mendums Pond (Figure VI-1). Sample location descriptions are found in Table VI-3. Two locations (P1, P2) were chosen for their proximity to Mendums Landing, the development under study.

Sampling periods were conducted for two week intervals in late July, early August, and again in late August to early September, 1988. A sampling period was also conducted for two weeks in July, 1989. This is the first time the

Table VI-2
Mendums Pond Dominant Zooplankton Genera

Date	Total Density (counts/ L)	Dominant Zooplankton	% of Total
07/08/87	43.6	Kellicottia	30
		Conochilus	20
		Polyarthra	20
08/06/87	sparse - no dominant		
09/11/87	41.4	Diaptomus	53
		Nauplius larva	
11/03/87	58.9	Daphnia	26
		Kellicottia	18
		Keratella	18
12/03/87	48.0	Diaptomus	41
01/22.88	Sparse - no dominant		
02/17/88	28.2	Keratella	30
		Kellicottia	28
02/29/88	Sparse - no dominant		
04/19/88	63.2	Nauplius larva	31
		Kellicottia	27
05/04/88	111.2	Kellicottia	49
06/01/88	234.8	Conochilus	40
		Kellicottia	23
		Gastropus	23

Table VI-2
Mendums Pond Dominant Zooplankton

Date	Total Density (counts/L)	Dominant Zooplankton	% of Total
06/15/88	128.3	Kellicottia	34
07/06/88	48.0	Kellicottia Ciliate spp	30 26
08/04/88	45.8	Keratella Diaptomus	38 33
09/08/88	54.5	Keratella	24
09/22/88	30.5	Nauplius larva Kellicottia	28 21
10/03/88	58.9	Diaptomus	33
10/31/88	41.4	Diaptomus	26
11/16/88	157.0	Solitary Unstalked Peritrich Cillate	60
01/17/89	Sparse - no dominant		
02/14/89	Sparse - no dominamt		
03/23/89	70.8	Rotifer spp	28
04/28/89	85.0	Nauplius larva Kellicottia	44 20
06/22/89	43.6	Conochilus Daphnia	55 35
11/09/89	72.0	Diaptomus Polyarthra	39 24
02/14/90	65.0	Rotifer spp	54
05/16/90	187.5	Kellicottia	56

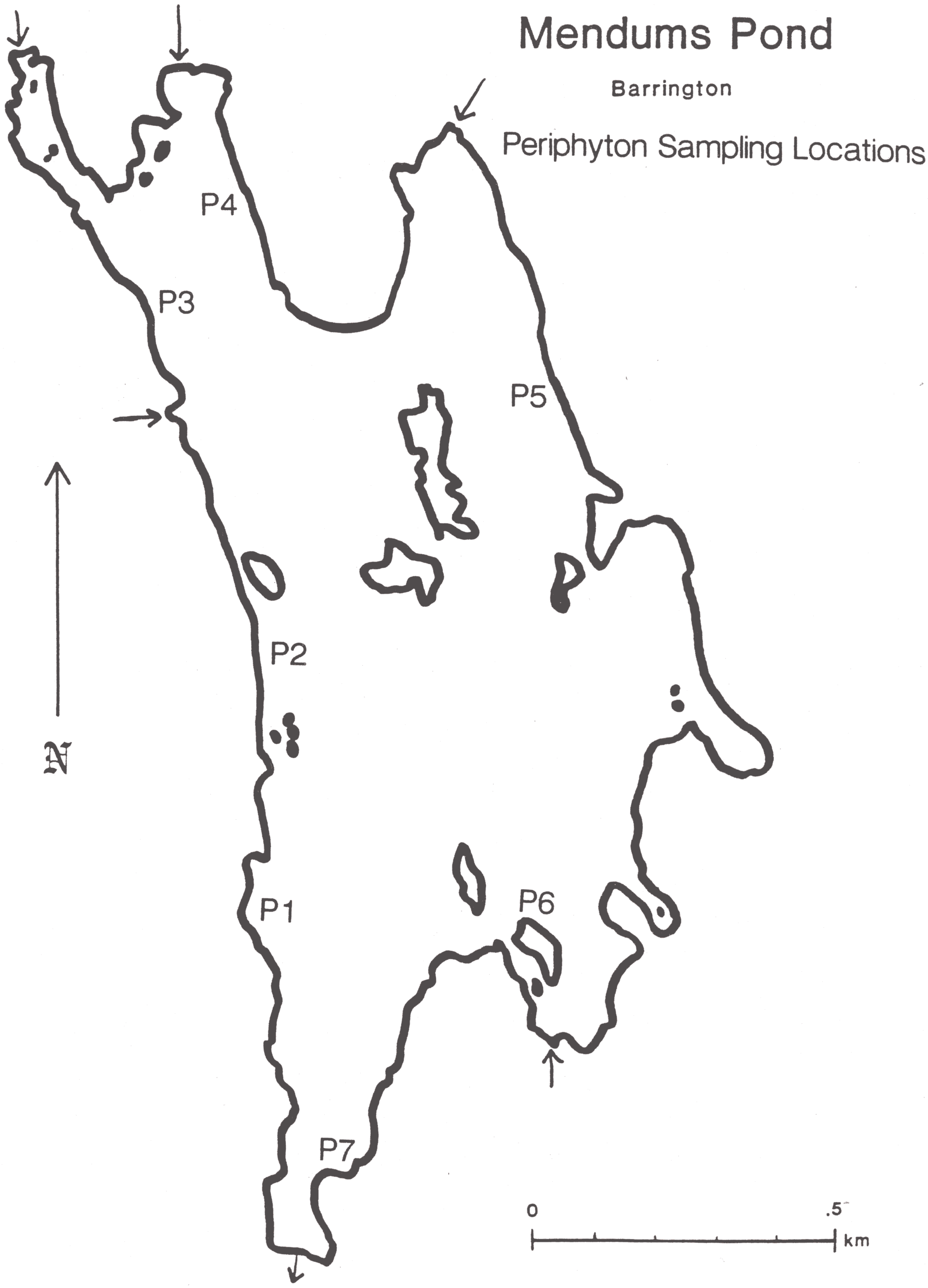

Figure VI-1 Periphyton Sample Locations

Table VI-3

Mendums Pond Periphyton Sample Location Descriptions

Site #	Description	Bottom Type	Station Maximum Depth (cm)	Sampler Height off Bottom (cm)	Sample Height (cm)	Distance From shore (m)
	wooded shore	mixed	170	59	111	1.7
P_1	active clearing to the shore					
P_2	wooded shore house adjacent in current use	mixed	173	61	112	1.73
P_3	cleared shore existing camps in use	boulders	162	66	96	1.62
P_4	wooded shore existing deve- lopment	sandy/ slope	174	56	118	1.74
P5	virgin wooded no development	gravely/ stoney	182	65	117	1.82
P_6	wooded shore used recrea- tionally	boulders	160	72	88	1.6
P_7	wooded shore	stoney/ leaf litter	175	59	116	1.75

Biology Bureau initiated a study of periphyton and hence the initial data was somewhat of a trial. The second sampling run showed data which we believe to be more reliable. The 1989 data was incomplete, and only chlorophyll-a data was analyzed. Periphyton data (autotrophic index information) is shown in Table VI-4.

A discussion of the sampling technique can be found in Chapter 4. Periphyton data can be analyzed by using: 1) the Autotrophic Index (AI) or 2) species composition to analyze for indicator species, associations, richness and relative species abundance.

Using the Autotrophic Index for periphyton analysis involves several parameters. Slides are analyzed for both Ash Free Dry Weight (hereafter referred to as AFDW) and chlorophyll-a comparison. Analysis of the AFDW will yield information on the combined mass of heterotrophic and autotrophic organisms and organic detritus. The chlorophyll-a analysis will yield information on the autotrophic organisms. These two parameters are then put into a ratio (AFDW/Chl-a) and the resultant value is referred to as the Autotrophic Index.

Organisms are divided into two groups, the heterotrophs and the autotrophs, according to their relationship with carbon and energy. Heterotrophs utilize organic carbon compounds (lipids, carbohydrates and amino acids) as energy sources and building blocks for growth and repair. Autotrophs utilize carbon dioxide as a carbon source, but their energy for changing CO_2 to carbohydrates comes from other sources (such as light energy or that released from changing chemical bonds) (Wallace et al 1981). The significance of the ratio between the two groups (the Autotrophic Index) is the determination of the enrichment of organic compounds in the waterbody. If organic matter is discharged into the waterbody the biomass of heterotrophic organisms will increase more rapidly than that of the autotrophic organisms. This will appear as an increase in the value of the Autotrophic Index (Collins & Weber, 1978).

The value of the Autotrophic Index significance varies in the literature. Standard Methods (17th Edition) states an AI value of 50-200 indicates normal, non affected water, with larger numbers indicating heterotrophic conditions or poor water quality. Collins & Weber (1978) state that an AI of 50-100 is common for waters containing negligable amounts of degradable organic matter, and values 400-1,000 and above indicate communities affected by organic pollution where heterotrophy dominates.

Table VI-4

Mendums Pond

Periphyton; Autotrophic Index

	Run #1 (mean of 3 replicates)	Run #2 (mean of 3 replicates)
P1	1587.3	182.3
P2	534.3	460.0
P3	1367.5	500.2
P4	4863.5	465.1
P5	1317.5	352.1
P6	216.8	412.7
P7	0.0	91.7

Mendums Pond

Periphyton; Chlorophyll-a

	Run #1 (mean of 3 replicates)	Run #2 (mean of 3 replicates)	Run #3 (mean of 3 reps.)
P1	0.23	0.56	0.14
P2	0.32	0.31	0.29
P3	0.15	0.36	0.49
P4	0.26	0.67	0.34
P5	0.26	0.19	0.13
P6	0.19	0.21	0.14
P7	0.14	0.43	0.14

Other factors must also be taken into account when utilizing the AI for analysis of water. The chlorophyll-a values obtained may vary due to other factors than nutrient enrichment. Errors may be made by neglecting to calculate the phaeophytin-a composition of the chlorophyll-a samples. Phaeophytin-a is a chlorophyll degradation product, found in dead and decaying cells, and unless samples are acidified to distinguish this from chlorophyll-a an overestimation of the chlorophyll-a content may occur (Collins, 1978).

Other factors may also influence the chlorophyll-a estimation. A periphyton study by Munn, Osborne and Wiley (1989) concluded that periphyton growth in streams draining agricultural lands was not nutrient limited. Most of the chlorophyll-a variences in that study were explained through physical characteristics of the stream (i.e. temperature, turbidity and light). Collins and Weber (1978) stated that the rate of periphyton colonization was largely dependent upon temperature, trophic level and water velocity. Another factor which may affect the chlorophyll-a estimation is the seasonality of the colonizing organisms. Liaw and MacCrimmon (1978) observed lower AI values (and higher chl-a/pheophytin ratios) in the fall, and accounted for this by the natural seasonal selection of more chlorophyllous-autotrophic organisms. This is supported by Biggs (1989) who stated that the AI has limitations for use due to the fact that it may be strongly influenced by early (or late) stages of community development when heterotrophs can dominate as a natural part of community succession. These factors are summarized well in Standard Methods (17th ed.) which states that, in addition to pollution effects, the length of substrate exposure, and seasonal changes in natural environmental conditions may have a profound affect on sample composition. Therefore, no community on an artificial substrate is completely representative of the natural community.

Two periphyton studies were conducted on Mendums Pond in 1988. The Autotrophic Index values vary widely between stations and sampling dates. The second run is considered to be the more accurate of the two.

The AI values for the second run (Table VI-4) ranged from a low of 91.7 (station P7) to a high of 500.2 (station P3). Most of the samples had AI values of greater than 400 which, if examined in light of historical studies, may cause some concern. However, other factors must be taken into account.

The chlorophyll-a values for these periphyton studies were not compensated for pheophytin-a, and therefore may be over estimated. The location of the samples also may have had an effect on the resultant AI values.

The sampling locations were selected in shallow nearshore areas. These areas are particularly vulnerable to turbidity increases by motorboats and other recreational uses. The ash free dry weight estimation includes organic detritus. Particles stirred up from the sediments may have settled on the sampling slides and caused an overestimation of the ash free dry weight calculation.

Species composition is another method used for periphyton analysis. Biggs (1989) summarized the overall effect of effluent on a periphyton community as a reduction in algal species richness and, to a lesser extent, density and diversity. Collins and Weber (1978) propose that community structure responds more slowly to changes in water quality than metabolic activities of the cells.

Periphyton sample analysis included only the phytoperiphyton, and thus do not take into account species of zooplankton, fungus, insects and other heterotrophs which may be present. Inverted microscope counts on all three samples show a diatom dominance of at least 57%. Secondary algal group dominants include bluegreens and non conjugating greens.

The periphyton study described in this section was intended to gather baseline data for future comparison. No real assumptions about the water quality of Mendums Pond can be inferred from this data at this time. With some method modification we expect periphyton analysis will prove a useful tool in water quality determination in the future.

C. Chlorophyll-a and Transparency

Chlorophyll-a is a measure of the biomass (weight) of phytoplankton in a lake or pond. Secchi disk transparency is a measure of water clarity. Suspended matter in the water column, both living and dead and highly colored water reduces water clarity. Unless high concentrations of silt are present, there is generally an inverse correlation between chlorophyll-a and Secchi disk transparency (i.e. as the phytoplankton increases, the clarity decreases). This was true for Mendums Pond (Figure VI-2).

Maximum chlorophyll-a concentrations (9.67 and 8.22 ug/L) occurred on April 28, 1989 and on May 16, 1990 (Table VI-5). A surge in chlorophyll-a (i.e. phytoplankton growth) often occur during the spring turnover when more phosphorus is available. These dates correspond with the lowest transparencies recorded during the study: 2.3 meters on April 28, 1989 and 2.6 meters on May 16, 1990.

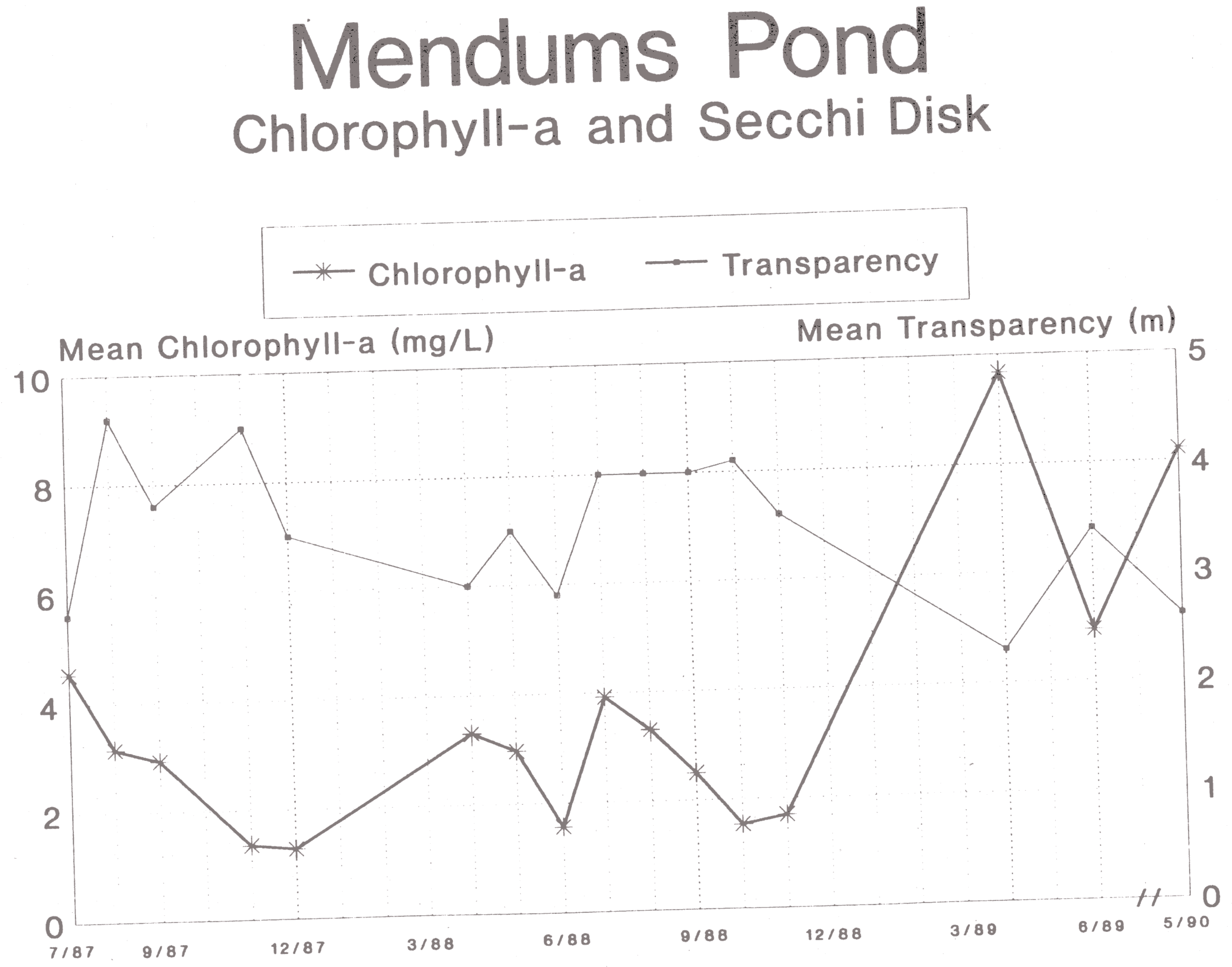

Figure VI-2 Chlorophyll-a and Secchi Disk Correlation

Table VI-5

Mendums Pond Chlorophyll-a and Transparency

Date	Chlorophyll-a(ug/L)	Transparency (M)
07/08/87	4.54	2.8
08/06/87	3.15	4.6
09/11/87	2.93	3.8
11/03/87	1.36	4.5
12/03/87	1.28	3.5
04/19/88	3.31	3.0
05/04/88	2.97	3.5
06/01/88	1.57	2.9
07/06/88	3.92	4.0
08/04/88	3.31	4.0
09/08/88	3.00	3.6
09/22/88	2.10	4.5
10/31/88	1.54	4.1
11/16/88	1.70	3.6
04/28/89	9.67	2.3
06/22/89	4.93	3.4
05/16/90	8.22	2.6

The lowest chlorophyll-a concentrations for the entire study period occurred in late fall. This can be expected, due to the angle of sunlight incidence lesseing and productivity decreasing. Transparency during these times increased by nearly a meter's depth.

The mean chlorophyll-a concentration of 3.40 ug/L is lower than the state mean of 6.60 ug/L. The state mean was calculated utilizing almost 500 lakes and ponds statewide. The mean transparency in Mendums Pond was 3.5m, just under the state mean of 3.9m.

D. Aquatic Vegetation

Plants growing in or around water are referred to as aquatic vascular plants. They are considered to be essential in maintaining a balanced lake ecosystem. An aquatic macrophyte (plant) survey was conducted on Mendums Pond on July 8, 1987. This was done as part of the lake assessment program conducted by the NHDES Biology Bureau. Table VI-6 shows each type of aquatic vascular plant found in Mendums Pond, its abundance and its code letter. Code letters serve as a key for Figure VI-3 (Staff Report No. 166, 1989).

The macrophyte community was dominated by *Dulichium arundinaceum*, or three-way sedge. The overall abundance was considered scattered, meaning that aquatic plants were not a problem or nuisance at Mendums Pond.

E. Fisheries

Fish are not currently stocked in Mendums Pond. Historically small mouth bass were released in 1952 and largemouth bass were stocked in 1961 (NHF&G, 1985).

Netting efforts in 1976 recovered only five fish (one smallmouth bass and four yellow perch). This was the least number of fish caught per netting hour in recent years by Fish & Game.

AQUATIC PLANT SURVEY

LAKE: MENDUMS POND TOWN: BARRINGTON DATE: 07/08/87

Key	PLANT NAME		ABUNDANCE
	GENERIC	COMMON	
L	Lysimachia terrestris	Swampcandle	Sparse
G	Gramineae	Grass family	Scattered
d	Dulichium arundinaceum	Three-way sedge	Scattered
Y	Nuphar	Yellow water lily	Sparse
W	Potamogeton	Pondweed	Sparse
X		Sterile thread-like leaf	Sparse
e	Eleocharis	Spike rush	Sparse
S	Sparganium	Bur reed	Scattered
U	Utricularia	Bladderwort	Sparse
f	Chlorophyceae	Filamentous green algae	Scattered
g	Gratiola	Hedge hyssop	Scattered
M	Myriophyllum humile	Water milfoil	Sparse
b	Scirpus	Bulrush	Sparse

OVERALL ABUNDANCE: Scattered

GENERAL OBSERVATIONS:

Table VI-6 Aquatic Macrophyte Key

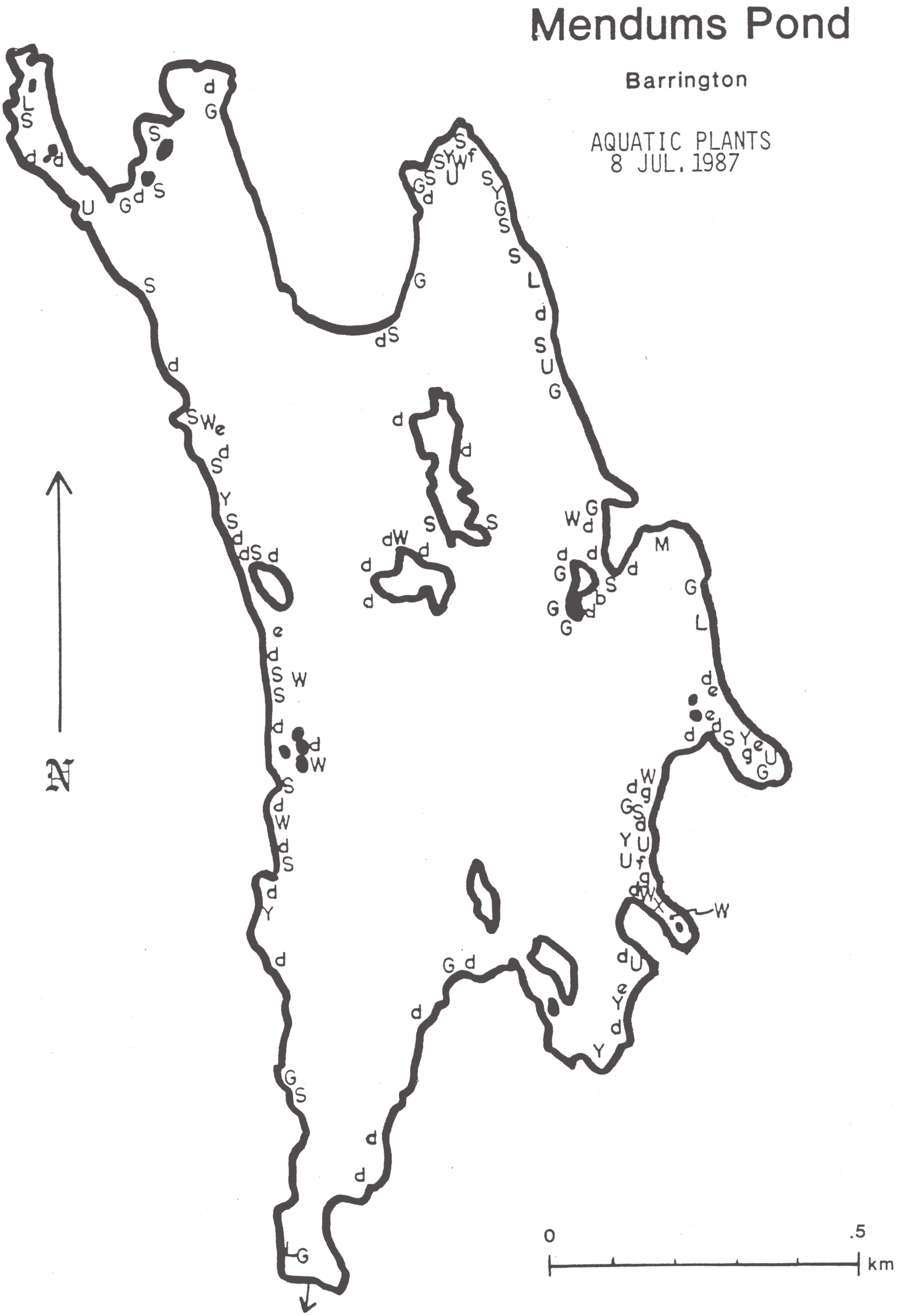

Figure VI-3 Aquatic Macrophyte Map